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ABSTRACT

In a very short time, data processing has grown from virtually nothing to a position of great importance in the technical scientific system of civilization in the Federal Republic of Germany. Both the public and private sectors have contributed significantly to this expansion. Research and development have now reached large proportions. Thus there is a considerable requirement for skilled staff, i.e., data processing specialists with or without university or technical college training. Despite large computer facilities already in operation, there are no indications of a saturation of the market. Software needs are showing changed trends; growth in hardware cannot be halted. Small computers and medium data processing plants are forging ahead, but a micro processor market is still in its infancy. In the area of personal protection from data abuse, the Federal Data Law was passed in 1977. Achievement by data processing research, technology, and industry in the Federal Republic of Germany has gained recognition from the rest of the world. (VT)

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Dialogue with the Computer

- Data Processing in the Federal Republic of Germany -

by Hermann M Steiner

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Dialogue with the Computer
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	Page
Technical terms absorbed into the vernacular	1
"Data Processing Assumes a Key Position"	1
1936 Premiere in Berlin	2
Independent experts advise the ministeries	3
Promotion given in three Government programmes	5
Industry spares no expense	5
Focal points research and development	7
State major research organisations	8
Specialists essential	9
Three categories of data processing occupations	10
Beginning of 1977: 122,114 electronic computers	11
No saturation of the market	13
Change in software manufacture	13
Growth in hardware cannot be halted	15
Medium and small data techniques on the increase	16
A million lines printed per hour	17
Success on the world market and international cooperation	18
Protection from data abuse	19

(INP). A jubilee edition of the distinguished Bertelsmann encyclopaedia was published in Gütersloh in 1960. The four tomes of the eleven volume lexicon contain around 100,000 individually mentioned keywords. However, no mention is made of even basic data processing expressions such as "Data/Data Processing/Electronic Data Processing/Transfer of Data", "Computer Science/Information Theory/ Information Processing","Computer/Calculator" or "Bit/Hardware/ Software". They are mentioned neither individually nor in summarised form. The editors evidently thought them of insufficient lasting and general importance. This became unthinkable a short time later in the Federal Republic of Germany and elsewhere.

In 1966, only six years later, the Brockhaus encyclopaedia, published in Wiesbaden, gave each of the twelve technical terms quoted its own keyword. About every ten printed pages of text is accompanied by a half-page schematic diagram and a whole-page colour tabulation. The text as such contains, inter alia, around 220 references to further keywords and relevant points of emphasis. The reader is given detailed information about approximately thirty basic technical books; already including the reference books relating specifically to the data processing sector.

In 1977, even comic strip language can no longer do without these expressions - as well as many contiguous ones. Within seventeen years technical expressions which appeared exotic to the layman as recently as 1960, have become an accepted part of the vernacular. The influence exerted on the German public by the data processing sector has menatime become so far-reaching that the Data Technology Information Centre in Saarbrücken regularly publishes a special data technology pocket book 250 pages in length. In the 1977 edition, the reader can find, inter alia, a list of 27 trade fairs and exhibitions taking place throughout the year; name, title, addresses and precise special data of 311 German technical journalists and authors as well as 268 technical publications in the German language, an index of 153 computer centres, data processing and technical measuring and standards institutions belonging to West German scientific universities alone.

"Data Processing Assumes a Key Position"

In an incredibly short time, data processing has grown from what appeared to be nothing to a position of great importance in the

technical scientific system of civilization in the Federal Republic of Germany. Its progression into the top group of turnover-makers cannot be halted. It is becoming indispensable in an increasing number of areas of research and technology, commerce and administration. At the same time, although initially only a product, it has developed into a basic element, impetus and motor of progress. The number of achievements triggered off by, brought within reach and made possible by data processing has snowballed.

Siemens AG, Germany's leading large-scale computer manufacturer, prophesies the start of a new age. "A third element, information, has joined matter and energy." The Federal Government in Bonn gave a more sober assessment when presenting its 1976 Third Data Processing Programme: "Data processing occupies a special key position among modern technologies. It is itself not only a branch of the economy with a secure future but also a significant component of the infrastructure necessary for economic and social further development."

On the basis of an assessment of this kind, shortly after the founding of the Federal Republic, data processing was given intensive public promotion. It has progressed steadily since this time and the pace is hardly likely to slacken in the near future. It is, after all, responsible for the fact that today, despite considerable difficulties in the past, the Federal Republic of Germany is again in top position in the data processing field among manufacturing, utilizing, researching and developing countries.

1936 Premiere in Berlin

Data processing has a long history. Accounting aids were common even in ancient times. And what applied then applies equally today. Knowledge and skill, methods and programmes (nowadays "software") are the prerequisites for the usefulness and profitability of the apparatus (nowadays "hardware"). Initially, a logical mathematical theory had therefore to develop in the seventeenth and eighteenth centuries to give purpose to the appearance, after 1750, of the first controlled calculating machines, Jaquard's punch card method and other technical advances. Formal algebraic logic preceded the first scientific application of punch card technology around 1920 by about fifty years. The still recent discovery of the automatic machine theory, switched algebra and cybernetics provided the decisive pre-

preconditions for the first signs of computer usage in commerce which appeared in the forties and fifties.

German scientists and engineers played a considerable part in the wide variety of developments which are merely indicated by these keywords. For this reason, it is hardly surprising that if a definite date must be found, the world premiere of the data processing age undoubtedly took place in Berlin in 1936. It was there that the relay calculator Z1 was created by the young construction student Konrad Zuse; the first electromechanical calculating machine in history was presented. Modern electronic computers bear little resemblance to this scurrilous "early calculator". (Z1 used perforated cine film celluloid strips for programme control purposes). Nevertheless, this was the ancestor of all computors.

The development of data processing in the ensuing period did not fulfill the hopes raised in Germany by its impressive beginnings. Only three years after Konrad Zuse's invention, the Second World War broke out. This led to the isolation and destruction of Germany and in 1945 was followed by the difficult post-war years. During a period of particularly intensive world-wide research and development - also in the data processing sector - Germany was largely excluded. It was then that the other leading industrialised countries left Germany behind causing the "technological gap" which the Federal Republic was only able to close in the seventies. In 1949, two German nations were created in what had once been the German Reich. In the Federal Republic of Germany work at once commenced on reconstruction - which has often been called the German Economic Miracle.

Independent experts advise the ministeries

Right from the start, in their reconstruction efforts the fathers of this miracle allocated a special place to science and technology. Systematic promotion and assistance were therefore given as early as possible. The German Federal Government comments as follows on measures in the data processing sphere:

> "The promotion of data processing in the Federal Republic of Germany began in 1952 by the German Research Association at the universities. From 1966, universal discussion on the "technological gap" convinced the Federal Government that data processing installations are not only essential for

dealing with state and scientific commitments but growing in economic importance. Within the framework of six data processing activities, initially running along separate lines, the then responsible department for research and economics expended 353 million DM on data processing promotion between 1967 and 1970; 70 percent of this on developing data processing systems and associated research projects on data processing technologies, computer structures and languages.

The 1971-1975 Second Data Processing Programme combined all the Federal Government's promotion activities. Promotion, application and training were vastly improved. A total of 1,811 milliard DM were made available. 21 percent of this was intended for measures in the university sphere, 31 percent for data processing application, 40 percent for industrial research and development and eight percent for special programmes."

Maximum realism was coresponsible for the good effects of these promotion measures. The Federal Government has never relied solely on the technical competence of its ministeries when planning but additionally continuously sought the advice of independent experts in all fields. At the present time, specialists from home and abroad regularly cooperate in six advisory committees. Each one has special experience in the data processing sector or its area of application.

- Data Processing Committee of Experts D.FA
  with superior guidance, control and resolutionary functions
- Ad hoc Committee DV.AD.01
  Data processing in the education system
- Committee of Experts DV.SK.01
  Data processing systems and technologies
- Committee of Experts DV.SK.02
  Data processing in the health system
- Committee of Experts DV.SK.04
  Computer assisted development and construction
- Committee of Experts DV.SK.05
  Process control by means of data processing plant

Promotion given in three Government programmes

Currently the Federal Government's Third Data Processing Programme is in operation. Expenditure of around 1.57 milliard DM is foreseen for 1976-1979. For the first time the promotion of data processing application in information systems, the health and education system, in development and construction, process control and other commitments are well to the fore. Envisaged expenditure in this sector rose from almost 128 million DM (1976) to 157 million DM in 1979 reaching a total of 561.6 million DM. The practical use of data processing achievements is being pushed ahead with energetically.

Monies for measures contained in the Third Data Processing Programme (DM millions)

Data processing application	561.6
Promotion of industrial research and development	554.3
University and training sector	264.2
Operation and investment by the Federal Mathematics and Data Processing Society	194.8
Total monies for measures contained in the Third Data Processing Programme 1976-1979	1,574.9

Therefore the three data processing programmes so far devised by the Federal Government embrace a total of around 3.8 milliard DM and are growing constantly. The average annual promotion measures in the First Data Processing Programme were 88 million DM, in the second 362 million DM and in the third 394 million DM. A finance framework of around 401 million DM is envisaged for the final currently planned promotion year 1979. This is 48 million more than was expended in the entire four year period of the First Data Processing Programme.

Industry spares no expense

Promotion expenditure by the public purse in favour of data processing was considerably higher than the Data Processing Programme led to believe. Although in the early seventies the Bonn Federal Government itself concentrated the bulk of its promotion activities in the sphere of responsibility of the Federal Minister of Research and Technology, there remained a considerable number of measures which were not financed within the framework of the data processing programmes. These

include projects coming within the aegis of the Interior, Defence, Health and Postal ministeries. The eleven German Federal States have also participated from 1949 to the present day in data processing progress in a wide variety of ways and with sizeable sums of money.

Over the years, heavy expenditure has benefited promotion commitments in indirect ways difficult for outsiders to identify. An example of this is the German Research Association. This autonomous organisation of the German sciences is financed by the state, the economy and various foundations. The monies it receives, around 700 million DM in 1977, are donated by commissions of leading scientists mainly for the promotion of research in all areas of science to German universities. Since the fifties these institutions alone have spent between 15 and 20 million DM annually on equipping German universities with data processing apparatus.

However, the extremely high level of contributions made by the German economy itself should also be mentioned. As the example of the German Research Association has shown promotion monies are also contributed regularly indirectly from this sector; those made by concerns themselves are of disproportionately greater importance. The German economy has always enjoyed an important position in research and development among the countries of the world. 1973-1974 are the last for which final figures have so far been compiled on a world-wide basis. At that time, the economy of the Federal Republic of Germany had the third largest financial and staffing costs for research and development after the USA and Japan. Its total expenditure rose from around 11.8 milliard DM in 1973 to 12.7 milliard DM in 1974.

Data processing as an extremely research and development intensive branch with above average anticipated growth plays an extremely important role. An example: the majority of German hardware and accessories producers - which include machine building, the office machinery industry and other sectors - are part of the electrical industry. Following a recent increase of 15.8 percent compared with the previous year, this group with over 36,000 employees produced apparatus and equipment for automatic data processing worth over 4 milliard DM in 1976.

In mid 1977 the Central Association of the Electrical Industry stated in Frankfurt: "Within the framework of what is economically justifiable, electrical concerns spent about 12 percent of their turnover in 1976 on research and development. Expenditure on research and development was about twice as high as investment expenditure in the narrower sense." Using this as a basis it can be calculated that for 1976 alone expenditure on research and development by West German electrical concerns totalled 320 million DM in the data processing sector. Consequently a further 160 million DM was placed in traditional areas of investment - mainly production.

Focal points research and development

Research and development in the data processing sphere have now reached large proportions in the Federal Republic of Germany. It is impossible to keep track of the large number of institutions concerned with many viewpoints of a multiplicity of competences and technical substantiations. There are many establishments, for example, which in addition to their main task of a different nature, have devoted their attention to one or other special matter on the periphery of data processing science and technology.

In the latest edition the main reference book, the Essen Sponsoring Association of the German Sciences' vademecum of German teaching and research centres gives 29 different specialized areas under the keyword Data alone:

Data-Analysis
Data-application orientated research
Data-evaluation
Data-automatic
Data-in building
Data-commercial
Data-electronic
Data-registration
Data-remote transmission
Data-geodetic
Data-linguistic
Data-medical
Data-non numerical
Data-numerical
Data - oceanographic
Data-software
Data-storage
Data-systems
Data-in technology
Data-technology, intermediate
Data-processing
Data-processing in medical practice
Data-processing plant
Data-processing centres
Data-processing stations
Data-traffic theory
Data-in transport
Data-hydraulic engineering
Data-centres

For the benefit of scientific academies, universities, technical colleges, comprehensive universities and research organisations in the Federal Republic of Germany, the index of the vademecum lists around 60 centres, institutes, chairs, specialized and special areas of research, seminars and departments in these fields. In addition, around 100 institutions are listed in the field of pure and applied mathematics, 22 in theoretical computer science and programming as well as 44 in computer structure and technology. However, to the hard core of actual data processing research belong many fringe areas of the natural and engineering sciences (such as guiding, measuring and controlling technology with around 25 establishments) as well as various Federal Government and Federal State research institutes and major research centres and numerous organisations which carry out research contracts.

State major research organisations

On 23 April 1966 the Federal Government and the Federal State of Northrhine-Westphalia, with its headquarters in Birlinghofen Palace near Bonn, set up the Mathematics and Data Processing Society to establish focal points for a variety of research and development activities. In 1977, over 600 people are employed in Birlinghofen, Bonn and Darmstadt, almost one out of two being a scientist. In 11 institutes, 5 departments and four staff centres belonging to this major German research establishment (basic 1977 budget: almost 56 million DM), work is conducted on an extremely wide range of topics. They describe their activities as follows: "The Mathematics and Data Processing Society concerns itself in the main with practical concepts and in this way contributes to the further development and improvement of data processing systems, the use of data processing and increasing the number of ways in which data processing can be used. Research and development activity covers the whole area of software, system research in public administration together with structural questions concerning future data processing systems. It also has the task of analysing the role played by data processing, the use of data processing and its effects on the state, politics and society. Based on its commitments and modus operandi, the Mathematics and Data Processing Society should be seen as a major research establishment between the university sphere on the one hand, and the economy's and industry's area of activity on the other."

The Information and Documentation Society set up in Frankfurt in mid

1977 by the Federal Government and Federal States, is to be something of a partner organisation on the user side of the data processing complex. According to the Federal Research Minister, Hans Matthöfer, it is to be "set up as the central research and infrastructure establishment for the entire field of scientific-technical information and documentation." With an annual budget of initially 19 million DM, the latest state major research establishment in the data processing field is to push ahead with computer science research, develop information systems and, on the basis of international cooperation, help to broaden the uses made of data processing possibilities.

Specialists essential

There is a considerable requirement for skilled staff. An example: in the Federal Republic in mid 1976 around 95,000 people were already employed as organisers, system analysts, programmers and in other fields, solely for the purpose of registering software and controlling its use. Because this highly qualified staff cost around seven milliard DM annually, when viewed more closely, data processing - the peak area of automation - proved to be particularly staff intensive. In the German user's data processing budget, staff costs account for the lion's share at an average of 46 percent.

Measures in the university and training sphere are the only focal point of the German Federal Government's Third Data Processing Programme for which expenditure regularly dates back to 1976-1979. A reduction of almost 50 percent is envisaged from almost 94 million DM in 1976, 65/1977, 57/1978 to only 49/1979. The reason is not a measured or expected decrease in the staff requirement. In contrast, there is a growing demand for qualified specialists from technicians and salaried workers with commercial training to specialised scientists with university training.

Demand for data processing staff from 1973-1978

Data processing specialists 1973		
in applied areas	210,000	
in manufacturers	30,000	240,000
Data processing specialists 1978		
in applied areas	360,000	
in manufacturers	40,000	400,000
Training requirement 1973-1978		160,000

Within a short period the data processing sector has therefore produced 400,000 jobs. According to the forecasts, this explosive growth will continue into the early eighties (admittedly hampered

by codetermining factors such as economic imponderables and the further increased use of data processing.) However, according to the Federal Government, then "there will be a marked drop in the large growth requirement of data processing specialists so characteristic of the past." Responsibility for education and training, schools and universities rests with the Federal States in the Federal Republic of Germany. If the Federal Government now slowly reduces its promotion measures in this field this does not indicate the complete satiation of the training requirement. Following 25 years of systematic university promotion in the field of data processing and a full decade of the Bonn data processing programme, the situation is regarded as sufficiently settled.

Three categories of data processing occupations

These new data processing jobs, most of which have only developed over the past twenty years, can be divided into three categories according to training courses.

- Specialist data processing staff with completed course of training without university or technical college training. These are largely staff employed in the hardware manufacturing field and on various service, organisational, controlling and distributing activities. Demands made on this group are now rapidly growing alongside technical scientific progress. Computer-assisted programming methods the control of operating systems with the aid of processors and other developments demand an increasing amount of basic knowledge of data processing in addition to pure specialised knowledge. According to Federal Government forecasts, a staff requirement shortfall of the order of 20,000 specialists is anticipated in 1978 with an annual number of available training places of 15,200.
- Data processing specialists with technical college training. They represent the senior intermediate group of specialists and managerial staff. Computer science as the basic science on which information processing via technical aids is based is an essential basic professional qualification: over 40 percent chose this as their main subject in a course of study whereas the remainder opted for the subsidiary subject computer science in addition to a mathematical, technical, commercial or other main subject. The Federal Government expects there to be a considerable initial shortage of training places. A demand for 26,000 specialists is forecast by 1978 against

against 3,000 required training places. From 1978, the annual requirement will be for 900 places, according to current expectations.

- Data processing specialists with university training: the elite of the data processing sector. Following the bringing into line with the demands of the future of the standards reached by computer science training opportunities at German universities and universities of technology between 1971 and 1973, these are only now aking themselves felt due to the four year duration of all courses of study. The 1973-78 personnel requirements to be met by training were estimated at 23,500 specialist staff by the Federal Government; there were however only 6,500 training places available. After 1978, the lack of data processing managerial staff should however soon be made good with 2,600 training places available annually.

Considerable contributions to meeting staff requirements and the further training of skilled staff in the wake of technical scientific progress are also made by means of data processing courses and seminars set up mainly by manufacturers. As early as 1973 a survey revealed around 180,000 occupied places at manufacturers' training courses all lasting 4-5 days. Incidentally, it is typical of the data processing sector - which is a specialised area still in its infancy - that there is a clear preponderance of younger year groups in the age structure of current participants. In the near future it will be possible to solve many problems of a personnel structural nature by menas of internal promotion within a company and changing around incumbents of posts with an anticipated simul aneous lower than average replacement requirement.

Beginning of 1977: 122,114 electronic computers

Every six months, Diebolds, a Frankfurt firm of business consultants, issues statistics on installed electronic computers in the Federal Republkc of Germany. It is regarded as the most topical, reliable and thorough source of information in this field. It states that in 1976 alone there were a further 14,482 computers installed in the country. For the first time, the total number of computers in operation exceeded 100,000. On 1 January 1977 a total of 114,181 electronic computers were in operation in West Germany:

15,745 universal computer systems
14,252 process calculators and mini computers
84,184 small computers and terminal systems

On the same date, a further 7,833 calculators were on order for German purchasers but not yet delivered. If this figure is included, the number registered was therefore 122,114 electronic computers.

At the present time the Federal Republic of Germany has a nine percent share of the world computer market. Only the USA - the largest industrialised country with around 70,000 installed universal computers and a 50 percent share of the world market exceeded this figure. All in all, the world market for electronic computers was as follows in 1976:

United States of America	50 percent
Federal Republic of Germany	9 percent
Other West European countries	21 percent
Other countries	20 percent

The amount of money invested is enormous. The product, electronic data processing, is one of the most fiendishly expensive, research and development intensive products of top line technology. Prices have continued to plummet since the early days if they are compared with performance. Only 20 years ago the same calculating performance of a central unit cost 1 million DM which today costs less than 1 DM. However, alongside this drop in prices, the requirement for calculating capacity, auxiliary plant, accessories and new uses has risen rapidly. Prices above the eight million DM mark for universal computers have long been comparatively common. For this reason, on 1 January 1977 the economy and public purse in the Federal Republic of Germany had invested nearly 30 milliard DM (Diebold statistics: 29,797.2 million DM) in hardware either in operation or on order. It has long been customary throughout the world to regard the number of existing data processing plants as a significant indication for assessing the scientific technological standard of a country. Here not only simple summations such as the actual hardware figures must be taken into account but also wider dimensions. Particularly revealing is, among other things, the so-called computer density factor: the relationship between the number of installed computers and a country's gross social product. At present the Federal Republic of Germany occupies fourth place in the world. In comparison with the leading countries, Switzerland, the USA and Great Britain, it is catching up due to the extremely rapid development of its data processing system.

No saturation of the market

Nearly 50,000 users are already operating their own computers in the Federal Republic of Germany. The number of individual offices which make regular use of date processing services, for whatever reason, is almost a million. At the beginning of 1977 a list of data processing service concerns operating in Germany gave almost 250 firms offering computer capacity for every conceivable purpose from research commitments to staff training, from book-keeping to manifold other solutions to problems by means of computer science. Indeed, the Federal Government is convinced that the number of busy service computer centres which are mainly used by small and medium concerns has already reached a total of around 400 with an annual turnover of the order of one milliard DM.

Despite these large computer capacities which are in operation there are no indications of a saturation of the market. On the contrary: the number of new commitments entrusted to 'colleague' computer appears as enormous as ever. This, despite the fact that the days are long past when in the euphoria of the early days, the believers in progress upgraded the computer to the status of an "electronic brain". In spite of its success, the calculator has remained a calculator. Basically, they differ from traditional calculating machines only by their high operating speed and ability to store any amount of data.

Formulating problems so that computers can overcome them by means of simple calculation: that is the art behind the advance towards an increasing number of solutions to problems. Today, software production is changing rapidly and thoroughly following the first decade of applied data processing in which it remained a world-wide area of operation for individualists. The methods developed in bewildering variations, often for the same purpose, are being replaced by greater uniformity. This confusion, which was extremely uneconomic, gave rise to the risk of error and communication difficulties, blocked the association, exchange and combined use of data processing.

Change in software manufacture

For some years, structural market changes have thrown changed trends in software production into relief. A short time ago (1973) a survey in the Federal Republic of Germany revealed that around 90 percent of all data processing progress had been developed by the users themselves. The remainder of the requirement was being met by

hardware producers. However, only a short time later (1975), the market research concern Infratest, reported over 70 special software concerns operating in the country which, with staffs of nearly 3,000, were heading for annual turnovers of 300 million DM. 866 programmes were available (57 percent commercial programmes, 13 percent scientific technical programmes, 30 percent system and service programmes). An increasing number of German data processing users are more frequently choosing software from a catalogue.

Hardware manufacturers are also taking part in this development. Siemens' customers are already able to refer to a programme library for many products, which significantly simplifies the solution of frequently recurring commitments. Complete programmes can easily be compiled; only the organizational linking pieces and extremely specific parts of programmes have to be "hand made". In any event, it is no longer necessary to devise a new programme every time it is used.

Uniform principles of software manufacture blaze the trail for a multi-use product. In discussions between experts, words such as standardization and norming are already cropping up indicating future development trends. Admittedly, where, when and to what extent they can be realised no one yet knows. A start has at least been made with devising tailor-made methods along "construction element" lines. An increasing number of small and mini software units are to make it possible to "assemble" suitable methods for a wide variety of purposes. A new milestone along this path are computerised user programmes. Software packages for various uses are combined from an assortment of stored programme construction elements: tailor-made.

Within the framework of its second and Third Data Processing Programme, the German Federal Government has expended considerable sums of money on promotion of this area of commitment. A supra regional Computer Science Research Programme envisages around 150 research groups at 20 German universities being involved in the final stage. 70 percent of the costs will be borne by the Federal Government, 20 percent by the particular Federal State. The list of 13 main topics describes the framework contents of the programme:

1. Theory of automatic machines and formal languages
2. Programme and dialogue languages and their translators
3. Computer organisation and switching gear

4. Operating systems
5. Information administration systems
6. Processes for digital processing of continuous signals
7. Computer technology
8. Automation of technical processes with digital calculators
9. Computer-assisted planning, design and construction
10. Ways of using data processing in medicine
11. Ways of using data processing in education
12. Use of data processing in industrial management
13. Ways of using data processing in the law and public administration

Growth in hardware cannot be halted

In 1977 the turnover of hardware manufacturers in the Federal Republic of Germany reached an anticipated total volume of around 10 milliard DM. In addition there are numerous auxiliary areas such as the servicing and maintenance of installed hardware - solely the affair of the manufacturers - on which around 1.5 milliard DM per year is already being spent. The growthrates for the whole market from magnetic tapes to universal data processing plant forecast by the market researchers allow an average increase of ten to 20 percent of varying individual amounts into the eighties.

Combined manufacture and an ever decreasing number of producers made it possible to achieve interesting economic results. Today, only one German manufacturer, Siemens AG, offers large computers "made in Germany" for sale at home and abroad. Siemens does this very successfully; since 1972 the value of the Siemens plant park installed world-wide has more than doubled. On the home market, the German electrical concern has already been able to take almost a quarter of the market from its American competitors which at first appeared to dominate the market, whereas the share of the largest fellow competitor fell steadily from 72 percent in 1965 and is at present under 60 percent.

This is also the result of energetic research and development policy. As long ago as 1957 Siemens again moved back into the leading group of data processing manufacturers. Model No 2002, the first fully transistorised computer in the world, made its debut. Today, the still brand new youngest Siemens computer generation, Model 7000, represents one of the first series in the history of data processing

with construction elements of up to 16,000 Bit capacity. They include a wide range of high performance apparatus, such as machines capable of reading 1,000 punch cards or 150 documents per minute and writing 21,000 lines. Siemens' data transmitting plant - essential for combining various central units or the development of a wide ranging data network enabling hundreds of data stations great distances apart to correspond by means of a central computer - can be increased to transmitting ratios of 50,000 Bit per second for special purposes.

Experts estimate that universal computer systems at prices of from 1 million DM will have the smallest share in turnover growth in the data processing branch in coming years. Despite the high value of individual plants in the Federal Republic of Germany their share of the total value of installed computer production has already fallen to around 57 percent. The anticipated growth rate for the coming years is five percent.

Medium and small data techniques on the increase

Small computers (worth up to 250,000 DM) and medium data processing plant (worth up to 1 million DM per item) are now forging ahead. Whereas the upper section of medium data processing is also represented by only one German firm on the world market - Siemens AG and one of its subsidiaries - in the lower sections numerous Federal German firms are active. Alongside the leading Nixdorf Computer AG, whose turnover had already reached around half Siemens' turnover with medium and large plant three years ago, those leading the field are Philips GmbH, Kienzle Apparate GmbH, Triumph Werke AG, Anker Werke AG, Matth. Hohner AG and Diehl Datensystem GmbH.

Smaller computers justify themselves above all by their versatility. Small and medium-sized firms can afford to buy them. From a technical application viewpoint they are equally suited to a variety of rationalisation tasks and supervising and controlling technical systems (process calculators) for most scientific purposes and public commitments - such as in the health, police, administration or transport systems. Even large concerns already equipped with data processing need mini computers. The known uses of data processing are so highly rated today that with central units already having proved their worth, there is a gradual move towards developing dense data infrastructures with terminals even reaching to individual workplaces.

In the Federal Republic of Germany there are now mini computers costing up to 250,000 DM each with a total value of around 6 milliard DM in operation. They have a roughly 21 percent share of the value of total installed data processing plant. Expected growth is enormous - annual growthrates of the order of one third into the eighties. Forecasts are also good in the medium data processing field which already has a more than 22 percent share of the value of plant installed throughout the country.

A completely new market has developed in recent years at the lower end of the data processing range, so to speak, with the invention of micro processors. 20,000 and more information units can now be registered on a paper-thin plate made of the non metallic element silicium, measuring only five by four millimetres in size. German manufacturers hope to be able to offer micro processors with over one million transistors. The data processing construction element "to fit into the palm of the hand" is guiding data processing in completely new directions towards the car or house management. Additionally, these minute programmable construction units extend the range of computer application, as data processing infrastructure terminals in measuring stations, for example, on machines and elsewhere. Finally, they can also be used as computer construction elements. A data dissemination system bearing all the characteristics of a complete micro computer can be built up from only three micro processors and a few supplementary elements.

A million lines printed per hour

The micro processor market is still in its infancy in the Federal Republic of Germany. Experts estimate that at an annual turnover of around 50 million DM the possibilities have not even begun to be tapped. The trade expect to double their turnover every twelve months for many years to come - and this should have reached between 600 and 700 million DM by 1985.

In order to make better use of capacity and the speed of their data processing plant and to be able to find an increasing number of uses, German hardware manufacturers are working at top speed to develop more efficient supplementary and auxiliary plant. Spectacular presentations such as Siemens' Laser printer 3352 which writes about one million lines (around 13,000 printed pages) of absolutely clear print, naturally create world-wide interest. Systems for registering, collecting and storing data, improved terminal systems for the user's

dialogue with the computer in addition to high performance apparatus and aids for the remote transmission of data are some of the focal points of current development activity.

Success on the world market and international cooperation

Achievements by data processing research, technology and industry in the Federal Republic of Germany have not gone unnoticed in the rest of the world. It is for this reason alone that Siemens is becoming an increasingly important competitor internationally and meantime holds around eight percent of the European market. Exports by data processing manufacturers within the German electrical industry rose by almost 31 percent in 1976 compared with the previous year to around 2.9 milliard DM. In contrast, imports into the Federal Republic of Germany of similar products which rose by 23.6 percent and totalled 2.55 milliard DM clearly stagnated. The fact that German data processing producers are able to sell their products successfully even on the American and Japanese markets is the clearest sign of the lofty position it has reached among the leading nations of the world.

International initiatives towards cooperation by German data processing manufacturers and software houses with foreign firms include joint research and development projects, reciprocal licence agreements, as well as supplies for reciprocal production. All the larger concerns which develop, manufacture and sell data processing plant in Europe have also amalgamated into the European Computer Manufacturers' Association (ECMA) in order to press ahead with standardization jointly and to discover further possible uses for data processing systems.

In its Third Data Processing Programme, the Federal Government stated: "International cooperation in research and development furthers national research policy aims. Over and above this, it also makes important contributions to the Federal Government's foreign policy". It therefore furthers direct cooperation between German industrial concerns and scientists and their foreign partners, smoothing its path where necessary or advisable by talks with the Government and concrete promotion measures.

Naturally enough the emphasis of multilateral cooperation lies in the European Communities. In the bilateral sphere, special attention is merited by joint projects with Brazil (information networks, data processing in teaching, process control, computer networks, theoretical

computer science), Czechoslovakia (data processing in medicine, regional computer centres and use of data processing in statistics, process control), France (computer-assisted development and construction, data processing in medicine), Japan (data processing in medicine), and Canada (data processing in medicine, data processing in teaching). The Mathematics and Data Processing Society has extremely wide contacts throughout the world which are constantly being extended. The result of all these efforts in the field of international cooperation can be judged daily by members of the trade by the valuable practical progress made. The following is one of many examples: the eight main international data bank services are now at the disposal of German interested parties and can be effortlessly used via various suppliers and networks.

Protection from data abuse

As data processing grows in importance the effects on the individual become more direct and frequent with the forecasts made by critical observers becoming more apparent. A far-reaching, revolutionary development like the "data processing revolution" which has taken place since the fifties, with the immense wake of impingements and influences on all areas of life, is impossible without mistakes, blunders and undesirable effects. Constant critical control enables necessary corrections to be made at the right time.

The effects of data processing on the labour market are, for example, typical of this. The computer is not a welcome colleague everywhere. Data processing systems have, for example, been modified at enormous expense for use in the media. In newspaper editorial offices the computer is used simultaneously for research and documentation purposes, as an organizational aid and as typesetter. The editor feeds his text direct into the terminal by typewriter, he can make any required corrections on the screen and thus simultaneously do the work of the typesetter. However impressive the industrial management and technical labour advantages may be many journalists feel themselves to be reduced to the status of "editricians", many typesetters and printing experts fear for their jobs.

A far-reaching survey has just been completed by the Federal Labour Institute's Nuremberg Institute for Labour Market and Vocational Research. It has taken into account all affected occupations and a wide variety of developments. One thing is now clear: data processing is of such great importance to economic development that it pays to

develop suitable strategies to counter intolerable side effects such as far-reaching changes in the world of work or the dreaded removal of jobs by automation.

Whether as a result of the computer's help man will forget how to calculate or whether the threat exists of faulty decisions based solely on facts being made due to the "stupidity" of data processing plant, whether increased use of computers in the economy, science, law, politics and administration also carry the risk of blunders with more far-reaching effects: final answers must be found to these and many other questions. Considerable expense and effort is being devoted to this group of problems in the Federal Republic of Germany.

This applies, for example, to the area of data protection which is being discussed world-wide. The "registered citizen" of the future about whom hundreds of data concerning health and family, occupation and financial situation, moneysense, education, habits and hobbies and countless other factors will soon be registered somewhere (and therefore reachable) by virtue of numerous data processing activities must not fall victim to indiscretion, data errors or even criminal intentions. For this reason, a law for the protection from abuse of personal data in data processing (Federal Data Law) was passed in Bonn on 27 January 1977) which has provided new impulses for world-wide development in this field. It by no means provides an answer to every question and many points have even attracted criticism and all experts share the view that it must be further improved and tightened up in the future.

However, the Federal Data Law again demonstrates the view predominating in the Federal Republic of Germany that the possible uses of data processing are wide enough to justify the considerable efforts needed to overcome its disadvantages.

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